

AMENDMENTS TO THE DRAWINGS

Replacement sheets are submitted herewith which more legibly reproduce the cross-sectional TEM photographs depicted therein. There are no changes to the drawings and the replacement sheets do not introduce new matter.

Attachment: 4 Replacement Sheets (Figs. 1, 2, 5 and 6)

REMARKS

Claims 1-37 are all the claims pending in the application. The claims have been amended to replace the article “A” with “The” to reflect the dependency of claims 2-23 on independent claim 1 and claims 25-37 on claim 24. Claim 24 has been amended to include all of the limitations of device claim 1. If device claim 1 is allowed, Applicants respectfully request rejoinder of withdrawn method claims 24-37 pursuant to MPEP § 821.04.

Applicants submit herewith replacement drawings for Figs. 1, 2, 5 and 6 which depict cross-sectional TEM photographs photocopied from full-tone sheets. It is believed that the replacement sheets are legible and fully comply with 37 C.F.R. § 1.84, and withdrawal of the foregoing objection is respectfully requested.

In response to the objection to claims 2-23, the claims have been amended per the Examiner’s suggestion, and withdrawal of the objection is respectfully requested.

Claims 1-5, 14-18, and 21-23 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent 6,881,983 to Narayan et al. (“Narayan”).

Narayan was cited as disclosing active GaN/InGa_N quantum well superlattice layers in a high efficiency light emitting diode structure (Figs. 1 and 2) comprising a sapphire substrate 6, a Si-doped n-type GaN layer 4, an active region 8, and a Mg-doped p-type GaN layer 10 formed on the sapphire substrate 6, the active region 8 being sandwiched by the Si-doped n-type GaN layer 4 and the Mg-doped p-type AlGa_N layer 10A, and the active region 8 comprising a thick portion and a thin portion (Fig. 1), wherein the active region is said to have a “flat” lower surface (on the substrate side) and an uneven upper surface so as to form the thick portion and the thin portion (Fig. 1 and 2).

Applicant traverse, and respectfully request the Examiner to reconsider for the following reasons.

Narayan does not disclose that “the active layer has a flat lower surface (on the substrate side) and an uneven upper surface so as to form the thick portion and the thin portion” as required by claim 1. As defined at page 13, lines 1-7 of the specification, the term “flat refers to the case where a difference of height between a depressed portion and a protruded portion, which is observed from aforementioned TEM cross-section photograph, is, for example, 1 nm or less.”

Referring to Fig. 1 and column 2, line 66 to column 3, line 2 of Narayan, none of the layers of the active GaN/InGaN quantum well superlattice are flat along any surface. Moreover, in column 3, line 38 to column 4, line 8 of Narayan describes that the thickness variation of active layers is important. Also, Fig. 1 of Narayan shows the thickness variation of the active layers, and both the lower surface and upper surface are uneven.

On the other hand, in the present invention, the active layer has a virtually flat lower surface (on the substrate side) and an uneven upper surface, which forms depressions and protrusions, so as to form the thick portion and the thin portion. By employing such structure, a reduction in emission intensity and deterioration due to aging can be prevented. However, the active layer disclosed in Narayan does not have such a structure, and therefore does not exhibit the above effects. Therefore, Narayan fails to teach each and every element of the claimed invention, and Applicants respectfully request reconsideration and withdrawal of the 35 U.S.C. § 102(e) rejection.

Claims 6-13 and 19-20 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Narayan.

Regarding claims 6-9, 11-13, and 19-20, the Examiner acknowledged that Narayan does not disclose the various thicknesses of the presently claimed gallium nitride compound semiconductor multilayer structure. However, pointing to the teachings of Narayan regarding the relationship of bandgap change to thickness (column 4, line 5) and regarding thickness variation in InGaN layers (column 4, lines 45-50), the Examiner maintained that it would have been obvious to use “thickness and thickness variation teaching of Narayan in the range as claimed” to discover the optimum or workable range by routine experimentation.

Applicants respectfully traverse.

Narayan does not lead one skilled in the art to arrive at the presently claimed multilayer structure. Narayan teaches that the thickness variation of the InGaN layers is more important than a fluctuation in In composition, whereas formula (1) relates bandgap change to thickness (c.f., column 3, lines 42-45 and 58-61).

The active layer disclosed in Fig. 1 of Narayan has a short-range variation (SR-TV) and a long-range variation (LR-TV). The thickness of the active layer varies finely in the short-range. The ranges disclosed by Narayan are for short-range variation between 3 to 4 nm (see column 3, lines 53 to 54) or between 2 to 10 nm (see column 4, lines 48 to 49) and long-range thickness variation between 50 and 200 nm. It would not have been obvious to apply ranges directed to variations in thickness to thickness itself.

On the other hand, the active layer of the present invention, as shown in Fig. 1, is composed of the thin portions denoted with A, B and C, and the other thick portion. The width of the thick portion is preferably 10 to 5,000 nm, more preferably 100 to 1,000 nm (see page 13, lines 22 to 24 of present specification). The thin portion has a width of 1 to 100 nm, more preferably 5 to 50 nm (see page 13, line 32 to 33 of present specification). Therefore, the

structure of the active layer of the present invention is very different from that of Narayan. Accordingly, the width of the thick portion, the thickness of the thick portion, the width of the thin portion, the thickness of the thin portion, and the difference in thickness between the thick portion and the thin portion and the like in present claims 6 to 13 cannot be derived by routine experimentation, on the basis of the teaching of Narayan or otherwise.

For the above reasons, it is respectfully submitted that the present claims are also patentable over Narayan, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,



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CUSTOMER NUMBER

Date: January 14, 2008